

## COURSE SYLLABUS AND COURSE REQUIREMENTS

### 2024/2025 SEMESTER I.

|                              |                                    |
|------------------------------|------------------------------------|
| <i>Course title</i>          | <i>System Theory</i>               |
| <i>Course Code</i>           | MSM615AENG                         |
| <i>Hours/Week: le/pr/lab</i> | 2/0/2                              |
| <i>Credits</i>               | 4                                  |
| <i>Degree Programme</i>      | Biomedical Engineering MSc         |
| <i>Study Mode</i>            | full time                          |
| <i>Requirements</i>          | exam                               |
| <i>Teaching Period</i>       | fall                               |
| <i>Prerequisites</i>         | -                                  |
| <i>Department(s)</i>         | Dept. of Technical Informatics     |
| <i>Course Director</i>       | Dr. Sári Zoltán                    |
| <i>Teaching Staff</i>        | Dr. Sári Zoltán, Dr. Schiffer Ádám |

## COURSE DESCRIPTION

A short description of the course (max. 10 sentences).

Neptun: [Instruction/Subjects/Subject Details/Basic data/Subject description](#)

Fundamentals of signals and systems, system modelling and representation. Description of linear systems in time, frequency and complex frequency domain. Mathematical description of signals, important signal categories, properties of signals. Properties of systems, linearity, time-invariance, stability etc. System analysis in the time domain, ODE representation of LTI systems, response functions, convolution, state-space representation. System analysis in frequency domain, Fourier-series, Fourier-transform, spectral representation of signals and systems. The complex frequency domain and its applications in system analysis, the Laplace-transform. Sampling and reconstruction, the Shannon-theorem and its interpretation. Representation and analysis of discrete-time signals and systems, discrete-time Fourier-transform, z-transform. FIR and IIR systems, fundamentals of digital filtering. Fundamentals of control theory, feedback control. PID controller, tuning of controller parameters.

## SYLLABUS

Neptun: [Instruction/Subjects/Subject Details/Syllabus](#)

### 1. GOALS AND OBJECTIVES

Goals, student learning outcome.

Neptun: [Instruction/Subjects/Subject Details/Syllabus/Goal of Instruction](#)

The course provides an insight into the fundamental concepts and techniques of signal processing, and the representation of linear systems in time-, frequency-, and complex frequency-domain. The main goal of the course is to equip the students with the basic tools required for the analysis of the input-output relation of continuous- and discrete-time systems based on the description of the characteristics and connections of the components and parts, applying the corresponding mathematical apparatus, and to give an introductory insight to the mathematical background of control systems engineering.

The course helps developing analytical thinking, problem solving, and provides solid foundations for fields involving image- and sound processing, communication networks, modelling and controlling of processes and systems.

### 2. COURSE CONTENT

Neptun: [Instruction/Subjects/Subject Details/Syllabus/Subject content](#)

#### TOPICS

#### LECTURE

1. Fundamentals of signals and systems, mathematical background
2. System representation and system properties, special signals
3. ODE representation of LTI systems, state-space, transfer function
4. Frequency domain representation of systems
5. Fourier-series of periodic continuous-time signals
6. The Fourier-transform and its applications

**PRACTICE  
LABORATORY  
PRACTICE**

7. Sampling and reconstruction, discrete-time Fourier-transform, DFT
  8. Fundamentals of filtering and digital filters
  9. Fundamentals of control theory
  10. The PID control and its applications
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  9. Fundamentals of control theory
  10. The PID control and its applications

**DETAILED SYLLABUS AND COURSE SCHEDULE**

ACADEMIC HOLIDAYS INCLUDED

**LECTURE**

| week | Topic  | Compulsory reading;<br>page number<br>(from ... to ...) | Required tasks<br>(assignments,<br>tests, etc.) | Completion date,<br>due date |
|------|--|---|---|------------------------------|
| 1.   | Fundamentals of signals and systems, mathematical background                                       | [1.]  |   |                              |
| 2.   | System representation and system properties, special signals                                       | [1.]  |   |                              |
| 3.   | ODE representation of LTI systems, state-space, transfer function                                  | [1.]  |   |                              |
| 4.   | Frequency domain representation of systems   | [1.]  |   |                              |
| 5.   | Fourier-series of periodic continuous-time signals   | [1.]  |   |                              |
| 6.   | Sampling and reconstruction, discrete-time Fourier-transform, DFT                                  | [1.]  |   |                              |
| 7.   | Consultation   |   | <b>Midterm Test</b>                             |                              |
| 8.   | Fundamentals of filtering and digital filters, Application of digital filters, IIR and FIR systems | [1.]  |   |                              |
| 9.   | <b>Autumn brake</b>  |   |   |                              |
| 10.  | Fundamentals of control theory   | [2.]  |   |                              |
| 11.  | Investigation of feedback control systems  | [2.]  |   |                              |
| 12.  | The PID control and its applications   | [2.]  |   |                              |
| 13.  | Consultation, Lab Project  |   |   |                              |
| 14.  | Retakes  |   |   | <b>Lab Project</b>           |
| 15.  |  |   |   |                              |

**PRACTICE, LABORATORY PRACTICE**

| week | Topic   | Compulsory reading;<br>page number<br>(from ... to ...) | Required tasks<br>(assignments,<br>tests, etc.) | Completion date,<br>due date |
|------|---|---|---|------------------------------|
| 1.   | Fundamentals of signals and systems, mathematical background      | [1.]  |   |                              |
| 2.   | System representation and system properties, special signals      | [1.]  |   |                              |
| 3.   | ODE representation of LTI systems, state-space, transfer function | [1.]  |   |                              |

|     |  |      |                     |                    |
|-----|--|------|---------------------|--------------------|
| 4.  | Frequency domain representation of systems   | [1.] |                     |                    |
| 5.  | Fourier-series of periodic continuous-time signals   | [1.] |                     |                    |
| 6.  | Sampling and reconstruction, discrete-time Fourier-transform, DFT                                  | [1.] |                     |                    |
| 7.  | Consultation   |      | <b>Midterm Test</b> |                    |
| 8.  | Fundamentals of filtering and digital filters, Application of digital filters, IIR and FIR systems | [1.] |                     |                    |
| 9.  | <b>Autumn brake</b>  |      |                     |                    |
| 10. | Fundamentals of control theory   | [2.] |                     |                    |
| 11. | Investigation of feedback control systems  | [2.] |                     |                    |
| 12. | The PID control and its applications   | [2.] |                     |                    |
| 13. | Consultation, Lab Project  |      |                     |                    |
| 14. | Retakes  |      |                     | <b>Lab Project</b> |
| 15. |  |      |                     |                    |

### 3. ASSESSMENT AND EVALUATION

(Neptun: Instruction/Subjects/Subject Details/Syllabus/Examination and Evaluation System)

#### ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

**Method for monitoring attendance** (e.g.: attendance sheet / online test/ register, etc.)

Attendance sheet. Maximum allowed absence: 30%.

#### ASSESSMENT

Cells of the appropriate type of requirement is to be filled out (course-units resulting in mid-term grade or examination). Cells of the other type can be deleted.

#### Course-unit with final examination

#### Mid-term assessments, performance evaluation and their weighting as a pre-requisite for taking the final exam

(The samples in the table to be deleted.)

| Type                | Assessment | Weighting as a proportion of the pre-requisite for taking the exam |
|---------------------|------------|--|
| <b>Midterm Test</b> | max. 100 % | 50 %   |
| <b>Lab Project</b>  | max. 100 % | 50 %   |

#### Requirements for the end-of-semester signature

(Eg.: mid-term assessment of 40%)

(Midterm Test  $\geq$  40%) AND (Lab Project is accepted (at least 40%))

#### Re-takes for the end-of-semester signature (PTE TVSz 50§(2))

The specific regulations for grade betterment and re-take must be read and applied according to the general Code of Studies and Examinations. E.g.: all the tests and the records to be submitted can be repeated/improved each at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

Midterm test can be retaken once during the semester.

**Type of examination** (written, oral): oral

**The exam is successful if the result is minimum 40%.**

**Calculation of the grade** (TVSz 47§ (3))

The mid-term performance accounts for **50** %, the performance at the exam accounts for **50** % in the calculation of the final grade.

**Calculation of the final grade based on aggregate performance in percentage.**

| Course grade     | Performance in % |
|------------------|------------------|
| excellent (5)    | 85 % ...         |
| good (4)         | 70 % ... 85 %    |
| satisfactory (3) | 55 % ... 70 %    |
| pass (2)         | 40 % ... 55 %    |
| fail (1)         | below 40 %       |

The lower limit given at each grade belongs to that grade.

**4. SPECIFIED LITERATURE**

*In order of relevance. (In Neptun ES: Instruction/Subject/Subject details/Syllabus/Literature)*

**COMPULSORY READING AND AVAILABILITY**

- [1.] A. V. Oppenheim, A. S. Willsky: Signals and systems, Prentice-Hall, 1982
- [2.] Jancskárné Anweiler Ildikó: Control Engineering, Pécs, PTE Műszaki Kar, 2016.

**RECOMMENDED LITERATURE AND AVAILABILITY**

- [3.] A. Metin: Biomedical Signal Processing, Academic Press Inc., 1994
- [4.] L. F. Chaparro: Signals and Systems using Matlab, Elsevier Inc., 2011